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APPLICATION
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LETTERS PATENT

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For: **ELECTROLUMINESCENCE DEVICE**
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ELECTROLUMINESCENCE DEVICE

CROSS REFERENCE

This application claims the benefit of Korean Patent Application Nos. 03-16013 filed
5 March 14, 2003 and 03-38514 filed June 14, 2003, the contents of which are incorporated herein
by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

10 The invention relates to an organic electroluminescent device, and more particularly, to
an electroluminescent device having an improved sealing structure.

2. Description of the Related Art

Electroluminescent devices have advantageous features suitable for next generation
display devices. For example, electroluminescent devices have a wide viewing angle, a high
15 contrast ratio and a high response speed. Electroluminescent (EL) devices are classified as
inorganic EL devices and organic EL devices based on the materials which form the light-
emitting layers.

FIG. 1 shows an organic EL device disclosed in U.S. Patent No. 6,489,719. The
disclosed organic EL device 1 comprises a substrate 2 having a positive electrode 3, a negative
20 electrode 5 and a light-emitting layer 4 disposed between the positive electrode 3 and the
negative electrode 5, and a sealing member 6 for sealing the substrate 2. Since the characteristics
of the light-emitting layer 4 of the organic EL device deteriorate when exposed to moisture, it is
necessary to isolate the light-emitting layer 4 from the moisture in the air.

Even if the substrate 2 and the sealing member 6 provide isolation, the sealing between the substrate 2 and the sealing member 6 is not perfect because of the physical properties of the adhesive 7 applied to adhere the sealing member 6 to the substrate 2. Thus, in order to minimize the amount of moisture infiltrating into the light-emitting layer 4 through the adhesive 7, it is preferable to reduce the thickness of the adhesive 7. In this case, however, there is a limit in reducing the thickness of the adhesive 7 because the adhesive 7 should be sufficiently applied to the substrate 2 and/or the sealing member 6 for the purpose of removing a gap therebetween. Consequently, in the organic EL device shown in FIG. 1 in which the gap (T) between the substrate 2 and the sealing member 6 is equal to the thickness of the adhesive 7 applied, it is difficult to satisfactorily prevent moisture in the air from infiltrating into the light-emitting layer 4, resulting in a shortened life of the organic EL device.

SUMMARY OF THE INVENTION

The invention provides an EL device having an increased life by minimizing infiltration of moisture in the air into a light-emitting layer of the organic EL device through an adhesive.

This invention separately provides an electroluminescent (EL) device comprising a substrate having a light-emitting portion and a sealing member sealing the light-emitting portion, wherein a groove accommodating a sealant is formed in at least one of seal portions of the substrate and the sealing member.

In various embodiments of the invention, the groove generally has a height of about 1 to 200 μm and a width of about 0.5 to about 3 mm.

In various embodiments of the invention, a peripheral portion of the seal portion of the substrate and a peripheral portion of the seal portion of the sealing member are generally adhered to each other.

5 In various embodiments of the invention, the peripheral portion of the seal portion of the substrate and the peripheral portion of the seal portion of the sealing member may be spaced apart from each other by spacers included in the sealant.

In various embodiments of the invention, some of the spacers are preferably disposed between the peripheral portion of the substrate seal portion and the peripheral portion of the sealing member seal portion. In this case, each of the spacers preferably has a diameter in the
10 range of approximately 1 to 25 μm .

In various embodiments of the invention, the spacers are accommodated in the groove, and each of the spacers preferably has a diameter equal to the sum of the height of the groove and approximately 0.1 μm .

15 In various embodiments of the invention, infiltration of moisture in the air into a light-emitting layer through an adhesive can be minimized, thereby providing an EL device having a prolonged life.

BRIEF DESCRIPTION OF THE DRAWINGS

20 These features and advantages of the invention will become apparent and more readily appreciated from the following description of the exemplary embodiments, taken in conjunction with the accompanying drawings:

FIG. 1 is a cross-sectional view illustrating a conventional EL device.

FIG. 2 is an exploded perspective view illustrating an EL device according to a first exemplary embodiment of the invention.

FIG. 3 is a cross-sectional view taken along the line III-III shown in FIG. 2.

FIG. 4 is a cross-sectional view illustrating a modification of the EL device according to
5 the first exemplary embodiment of the invention.

FIG. 5 is a cross-sectional view illustrating an EL device according to a second exemplary embodiment of the invention.

FIG. 6 is a cross-sectional view illustrating a modification of the EL device according to the second exemplary embodiment of the invention.

10 FIG. 7 is a cross-sectional view illustrating an EL device according to a third exemplary embodiment of the invention.

FIG. 8 is a cross-sectional view illustrating a modification of the EL device according to the third exemplary embodiment of the invention.

15 DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the exemplary embodiments of the invention, examples of which are illustrated in the accompanying drawings. Referring to FIGS. 2 and 3, an EL device 100 according to a first exemplary embodiment of the invention includes a substrate 110 having a light-emitting portion 115 and a sealing member sealing the light-emitting portion
20 115.

The substrate 110 may be formed of a transparent material, for example, glass, and the light-emitting portion 115 is generally formed at the center of the substrate 110. The light-emitting portion 115 has first electrodes 115a, a light-emitting layer 115c and second electrodes

115b sequentially stacked therein. The first and second electrodes 115a and 115b serve as a positive electrode and a negative electrode, or vice versa. The light-emitting layer 115c is formed of a material capable of emitting light according to an electrical signal applied to the first and second electrodes 115a and 115b. Each of the first and second electrodes 115a and 115b are electrically connected to a conductive line 116 extending outside the sealing member. The conductive line 116 may be integrally formed with the first electrode 115a or the second electrode 115b.

In this embodiment, the sealing member is a glass cap 120A, but it should be understood by one of ordinary skill in the art that the sealing member is not limited thereto. For example, the sealing member may be in the form of an insulating plate or an insulating film. Also, the sealing member may be, for example, a conductive metal cap. In this case, an insulating layer may be formed on the bottom surface of the metal cap in order to prevent a short-circuit between the conductive line 116 and the metal cap.

In the case of a passive matrix type light-emitting portion, as shown in FIG. 2, the first electrodes 115a are strips, and the second electrodes 115b are strips arranged so as to cross the first electrodes 115a. The light-emitting portion according to the invention is not limited to the passive type, and may be, for example, of an active matrix type using a thin film transistor.

In the case where the EL device according to the invention is an organic EL device, the light-emitting portion 115c may include a first transport layer for transporting one of positive and negative charges from the first electrode 115a, a second transport layer for transporting the other of the positive and negative charges from the second electrode 115b, and an organic light-emitting layer interposed between the first and second transport layers. The organic light-emitting layer generates an exciton by combination of the positive and negative charges transported from

the first and second transport layers. The organic light-emitting layer may be formed, for example, of copper phthalocyanine (CuPc), N,N'-Di(naphthalene-1-yl)-N,N'-diphenyl-benzidine (NPB) or tris-8-hydroxyquinoline aluminum (Alq₃).

In the case where the EL device according to the invention is an inorganic EL device, the light-emitting portion 115c may include a first insulating layer and a second insulating layer formed on facing surfaces of the first electrode 115a and the second electrode 115b, respectively, and an inorganic light-emitting layer interposed between the first insulating layer and the second insulating layer and having electroluminescence core atoms. The inorganic light-emitting layer may be formed, for example, of metal sulfide, such as ZnS, SrS or CsS, or alkali earth potassium sulfide, such as CaCa₂S₄, or SrCa₂S₄. As the electroluminescence core atoms forming an inorganic light-emitting layer together with these inorganic compounds, transition metals including Mn, Ce, Tb, Eu, Tm, Er, Pr and Pb, or alkali rare-earth metals are used.

In general, one of the first and second electrodes 115a and 115b is formed of a transparent, conductive material, through which light emitted from the light-emitting layer can be transmitted, for example, indium tin oxide (ITO), and the other is formed of a highly reflective metal, for example, aluminum.

In this embodiment, a groove 130 capable of accommodating a sealant is formed in a seal portion 111 of the substrate 110. The groove 130 may be spaced apart from the edge of the substrate 110, as shown in the left portion of FIG. 3. Otherwise, the groove 130 may be formed at the edge of the substrate 110, as shown in the right portion of FIG. 3.

The height (H) of the groove 130 should be determined such that the sealant can be continuously applied for coating without intermission while preventing unnecessary use of the sealant. The height (H) of the groove 130 may be, for example, about 1 to about 200 μm

according to the substance of the sealant. Also, the width (W) of the groove 130 should be in the range in which the sealant can be continuously applied for coating without intermission while preventing unnecessary enlargement of the substrate. The width (W) of the groove 130 may be, for example, about 0.5 to about 3 mm. Such a groove may be formed at the time of forming a substrate, and may be formed by cutting a seal portion of a flat substrate by sand blasting or etching.

The seal portion 111 of the substrate 110 and the seal portion 121 of the glass cap 120A are adhered to each other by the sealant 131 accommodated in the groove 130. The sealant is formed, for example, of an epoxy material. The sealant is coated between the seal portion 111 of the substrate 110 and the seal portion 121 of the glass cap 120A, more specifically, at an area in which the sealant can be accommodated in the groove 130 formed at the seal portion 111 of the substrate 110. In a state in which the sealant is accommodated in the groove 130, a peripheral portion 111a of the seal portion 111 of the substrate 110 is adhered to a peripheral portion 121a of the seal portion 121 of the glass cap 120A. Here, the sealant in the groove 130 has higher thickness than the height (H) of the groove 130 due to its viscosity. Accordingly, the sealant can be adhered to both the substrate 110 and the glass cap 120A when the seal portion 111 of the substrate 110 and the seal portion 121 of the glass cap 120A are brought close to each other. In a state in which the substrate 110 and the glass cap 120A are adhered to each other by the sealant, the sealant has a cross section as shown in FIG. 3. Here, in order to prevent the contamination of the substrate 110 or the light-emitting portion 115 due to overflow of the sealant, the groove 130 is not fully filled with the sealant. As shown in FIGS. 3 and 4, for example, there is a space between a side of the sealant 131 and the edge of the groove 130.

As described above, since the peripheral portion 111a of the seal portion 111 of the substrate 110 is adhered to the peripheral portion 121a of the seal portion 121 of the glass cap 120A without a gap which may be caused by the thickness of the sealant, it is possible to effectively prevent moisture in the air from intruding into the light-emitting portion 115.

5 FIG. 4 shows a modification of the EL device according to the first exemplary embodiment of the invention, which is different from the first exemplary embodiment described above in that the groove 130 is formed at the seal portion 121 of the glass cap 120A instead of in the seal portion 111 of the substrate 110.

Referring to FIG. 5, an EL device according to a second exemplary embodiment of the invention will be described by comparison with the EL device according to the first exemplary embodiment of the invention. A metal cap 120B according to this exemplary embodiment corresponds to the glass cap 120A shown in FIG. 2, taken along the line III-III shown in FIG. 2.

10 If the sealing member for sealing the light-emitting portion 115 of the EL device is in the form of an insulating glass cap, plate or film, the sealing member is generally adhered to the substrate 110 as in the first embodiment. However, if the sealing member for sealing the light-emitting portion 115 of the EL device is in the form of a conductive metal cap 120B, generally, an insulating layer should be additionally formed on at least the bottom surface of the metal cap 120B. Generally, however, forming an additional layer is disadvantageous in view of manufacturing cost.

20 However, as discussed in the following exemplary embodiment it is not necessary to provide an insulting layer. According to the second exemplary embodiment of the invention, there is provided an EL device having a small gap (G) between the substrate 110 and the metal cap 120B. In this case, an insulating layer is not formed on the bottom surface of the metal cap

120B. The sealing member according to this embodiment is not limited to the above-described metal cap, and a glass cap, plate or film can also be used as the sealing member.

The second exemplary embodiment is different from the first exemplary embodiment in that a spacer 132a is included in the sealant 131 and serves to maintain a gap (G) between the peripheral portion 111a of the substrate seal portion 111 and the peripheral portion 121a of the metal cap seal portion 121. Thus, short-circuiting between the conductive line (116 of FIG. 2) formed on the substrate 110 and the metal cap 120B can be prevented.

In particular, according to this embodiment, the sealant 131 is coated sufficiently enough to fill the groove 130 and to coat a portion of the peripheral portion 111a of the substrate seal portion 111. In such a state, if the substrate 110 and the metal cap 120B are brought close to each other, the spacer 132a included in the sealant 131 is disposed between at least a portion of the peripheral portion 111a of the substrate seal portion 111 and at least a portion of the peripheral portion 121a of the metal cap seal portion 121. Accordingly, the gap (G) between the substrate 110 and the metal cap 120B can be maintained constant.

The spacer 132a is generally spherical or cylindrical, and generally has the smallest diameter (D_1) possible while preventing a short-circuit between the conductive line 116 and the metal cap 120B. As the diameter (D_1) of the spacer 132a is reduced, the gap (G) between the substrate 110 and the metal cap 120B decreases, preventing substantially all the moisture in the air from intruding into the light-emitting portion 115. To meet this condition, the diameter (D_1) of the spacer 132a is generally in the range of about 1 to 25 μm .

FIG. 6 is a cross-sectional view illustrating a modification of the EL device according to the second exemplary embodiment of the invention, which is different from the second

exemplary embodiment of the invention described above in that the groove 130 is formed at the seal portion 121 of the metal cap 120B.

Referring to FIG. 7, an EL device according to a third exemplary embodiment of the invention will now be described by comparison with the EL device according to the second exemplary embodiment of the invention. A metal cap 120B according to this embodiment
5 corresponds to the glass cap 120A shown in FIG. 2, taken along the line III-III of FIG. 2.

According to the third exemplary embodiment of the invention, there is provided an EL device having a small gap (G) between the substrate 110 and the metal cap 120B. In this case, an insulating layer is not formed on the bottom surface of the metal cap 120B. The sealing
10 member according to this embodiment is not limited to the above-described metal cap. It should be understood by one with ordinary skill in the art that a glass cap, plate or film can also be used as the sealing member.

The third exemplary embodiment is different from the second exemplary embodiment in that a spacer 132b included in the sealant 131 is accommodated in the groove 130 and serves to
15 maintain a gap (G) between the peripheral portion 111a of the substrate seal portion 111 and the peripheral portion 121a of the metal cap seal portion 121. Thus, a short-circuit between the conductive line (116 of FIG. 2) formed on the substrate 110 and the metal cap 120B can be prevented.

As shown in FIG. 7, the sealant 131 is generally coated on at least a portion of the
20 peripheral portion 111a of the substrate seal portion 111. However, the sealant 131 is not necessarily coated widely enough to reach the peripheral portion 111a of the substrate seal portion 111. That is, the sealant 131 may be coated in the central portion of the groove 130, as shown in FIGS. 3 and 4. The spacer 132b included in the sealant 131 has a diameter greater than

that of the spacer 132a in the second exemplary embodiment of the invention, and maintains the gap between the substrate seal portion 111 and the metal cap seal portion 121 constant.

The spacer 132b is generally spherical or cylindrical, and generally has a diameter (D_2) corresponding to the sum of a height (H) of the groove 130 and the gap (G) between the substrate 110 and the metal cap 120B. The gap (G) is generally as small as possible to prevent moisture in the air from intruding into the light-emitting portion 115. Also, the gap (G) should be large enough to prevent a short-circuit between the conductive line 116 and the metal cap 120B. To meet these conditions, the diameter (D_2) of the spacer 132b is generally equal to the height (H) of the groove 130 plus approximately $0.1\ \mu\text{m}$.

FIG. 8 is a cross-sectional view illustrating a modification of the EL device according to the third exemplary embodiment of the invention, which is different from the third exemplary embodiment in that the groove 130 is formed at the metal cap seal portion 121.

As described above, according to the invention, an EL device having prolonged life is provided by preventing moisture in the air from intruding into a light-emitting layer through a sealant.

While this invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.